

APPENDIX A - APPLICABLE DOCUMENTS

The revisions of the documents listed below that are current at the time of Contract award are applicable to these Requirements.

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM

SECTION 1			
1.1	NHB 5300.4 (1A)	Reliability Program Requirements for Aeronautical and Space System Contractor's	Note 1
1.1	NHB 5300.4 (1B)	Quality Program Provisions for Aeronautical and Space System Contractor's	Note 1
1.1 5.1	NHB 5300.4 (1F)	Electrical, Electronic and Electromechanical (EEE) Parts Management and Control Require- ments for NASA Space Flight Programs	Note 1
SECTION 2			
2.5	S-311-98	Guidelines for Conducting a Packaging Review	See Metsat Project Office
SECTION 3			
3.1 3.2.1 3.5.2.2 (Appendix C)	GEVS-SE	General Environmental Verifica- tion Specification for STS and ELV Payload Systems, Subsystems and Components (TBD)	See Metsat Project Office
3.5.2.1 (Appendix C)	MIL-STD- 461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.	Note 1 or 3
3.5.2.1 (Appendix C)	MIL-STD- 462	Electromagnetic Interference Characteristics, Measurement of	Note 1 or 3
3.5.2.1 (Appendix C)	MIL-STD- 463	Military Standard Definitions and System of Units, Electromag- netic Interference and Electro- magnetic Compatibility Technology.	Note 1 or 3

SECTION 4

4.1	WRR 127-1	Range Safety Requirements	Note 1
4.1	MIL-STD-882	System Safety Program Requirements	Note 1
4.11	NHB 8060.1	Flammability, Odor, and Out-gassing Requirements and Test Procedures for Materials in Environments that Support Combustion	Note 1

SECTION 5

5.1 5.2.1 5.2.5 7.3.3	GSFC PPL	GSFC Preferred Parts List	See Metsat Project Office
5.1	GSFC 311-HDBK-001	Handbook for Selection and Acceptance of Electrical, Electronics, and Electromechanical (EEE) Parts for GSFC Spacecraft Applications.	See Metsat Project Office
5.1 5.2.1 5.2.3 5.2.5 7.3.3	MIL-STD-975	NASA Standard Electrical, Electronic, and Electro-mechanical (EEE) Parts List	Note 1 or 3
5.3.2.3	MIL-STD-490	Specification Practices	Note 1 or 3
5.3.2.4	MIL-M-38510	General Specification for Microcircuits	Note 1 or 3
5.3.2.4	MIL-H-38534	General Specification for Hybrid Microcircuits	Note 1 or 3
5.2.6	S-311-M-70	GSFC Specification, for Destructive Physical Analysis of Electronic Parts	See Metsat Project Office

SECTION 6

6.2.1	None	GSFC Materials Tips for Spacecraft Applications	See Metsat Project Office
6.2.1	TM 82275* (GSFC Mtr. No. 755-013)	Quality Features of Spacecraft Ball Bearing Systems	Note 5
6.2.1	TM 82276* (GSFC Mtr. No. 313-003)	An Evaluation of Liquid and Grease Lubricants for Spacecraft Applications	Note 5
6.2.1	None	Materials Selection Guide	See Metsat Project Office
6.2.1	N-84-26751* (NASA RP-1124)	Outgassing Data for Selecting Spacecraft Materials	Note 5
6.2.1 6.2.5 6.4	MSFC-SPEC-522	Design Criteria for Controlling Stress Corrosion Cracking	Note 4
6.2.1	MSFC-HDBK 527, JSC 09604	Materials Selection List for Space Hardware Systems	Note 4
6.2.4	ASTM Method E 595	Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment	Note 6
6.2.4	ESMCR 127-1	Range Safety Manual (for ETR)	See Metsat Project Office

SECTION 7 (Mod 25)

7.2.2 8.5.8	GSFC-S-313-100	GSFC Fastener Integrity Requirements	See Metsat Project Office
7.3.1	GSFC P-302-720(7/5/94)	Performing a Failure Modes and Effects Analysis	See Metsat Project Office

SECTION 8

8.5.8 8.9.d	MSFC-STD-655	Standard Weld Filler Metal, Control of	Note 4
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8.10.3	NHB 5300.4 (3A-2)	Requirements for Soldered Electrical Connections	Note 1
8.10.3	NHB 5300.4 (3G)	Requirements for Interconnect- ing Cables, Harnesses, and Wiring	Note 1
8.10.3	NHB 5300.4 (3H)	Requirements for Crimping and Wire Wrap	Note 1
8.10.3	NHB 5300.4 (3J)	Requirements for Conformal Coating and Staking of Printed Wiring Boards and Electronic Assemblies	Note 1
8.12	NHB 5300.4 (3L)	Requirements For ESD Control	Note 1
8.12	DOD-HDBK- 263	Electrostatic Discharge Control Handbook for Protec- tion of Electrical, Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	Note 3
8.12	DOD-STD- 1686	Electrostatic Discharge Control Program for Protection of Electrical, Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	Note 3
8.10.3 8.15.3.5	MIL-P- 55110	General Specification for Printed-Wiring Boards	Note 3
8.10.3 8.15.3.5	MIL-STD- 275	Printed Wiring for Electronic Equipment	Note 3
8.13.2.2	S-480-17	Meteorological Satellite (METSAT) Project Configuration Management Plan	See Metsat Project Office
8.15.3.5	NASA RP 1161	Evaluation of Multilayer Printed Wiring Boards by Metallographic Techniques	Note 2
8.17.1	MIL-STD- 45662	Calibration System Requirements	Note 3
8.19	MIL-STD- 105	Sampling Procedures and Tables for Inspection by Attributes	Note 3

8.21	NHB 6000.1	Requirements for Packaging, Handling, and Transportation	Note 1
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SECTION 9

9.2.1	MIL-STD-	Military Standard Product Clean-	Note 3
9.3	1246	liness Levels and Contamination Control Program	

SECTION 10

10.3.1		Information System Life-cycle and Documentation Standards	Note 2
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NOTES (SOURCES):

1. Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.
2. NASA/Scientific and Technical Information Facility, P.O. Box 8757, BWI Airport, MD, 21240.
3. Department of the Navy, Naval Publications & Forms Center, 5801 Tabor Avenue, Philadelphia, PA, 19120.
4. NASA/Marshall Space Flight Center, Documentation, Code CN 22D, Huntsville, AL, 35812.
5. National Technical Information Service, Springfield, VA 22161.
6. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

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APPENDIX B - ABBREVIATIONS, ACRONYMS, AND GLOSSARY

Abbreviations and Acronyms

ARAR	Accident Assessment Report
ASIC	Application Specific Integrated Circuit
ASTM	American Society for Testing and Materials
CAGE	Commercial and Government Entity
CCB	Configuration Control Board
CCP	Contamination Control Plan
CDR	Critical Design Review
CDRL	Contract Documentation Requirements List
CE	Conducted Emission
CIL	Critical Items List
CM	Configuration Management
CPT	Comprehensive Performance Test
CS	Conducted Susceptibility
CVCM	Collected Volatile Condensable Mass
DCR	Design Concept Review
DOD	Department of Defense
DPA	Destructive Physical Analysis
DRL	Document Requirements List
EEE	Electrical, Electronic, & Electromechanical
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOS	Earth Observing System
ESD	Electrostatic Discharge
FMEA	Failure Mode and Effects Analysis
FOR	Flight Operations Review
FRB	Failure Review Board
FRR	Flight Readiness Review
GEVS-SE	General Environmental Verification Specification for STS and ELV Payloads, Subsystems & Components
GFE	Government Furnished Equipment
GIA	Government Inspection Agency
GIDEP	Government Industry Data Exchange Program
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSi	Government Source Inspection
ICF	Instrument Control Facility
ICD	Interface Control Document
IAC	Independent Assurance Contractor
JSC	Johnson Space Center
LOD	Letter of Delegation
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
MOR	Mission Operations Review
MR	Malfunction Report
MRB	Material Review Board
MSFC	Marshall Space Flight Center
MUA	Materials Usage Agreement

MUH	Mission Unique Hardware
NASA	National Aeronautical and Space Administration
NDE	Nondestructive Evaluation
NHB	NASA Handbook
NSPAR	Non-Standard Parts Approval Request
NSPL	NASA Standard Parts List
OHA	Operations Hazard Analysis
ORR	Operations Readiness Review
ORU	On-orbit Replaceable Unit
PAPL	Platform Approved Parts List
PAR	Performance Assurance Requirements
PCB	Parts Control Board
PCP	Parts Control Plan
PDA	Percent of Defectives Allowable
PFR	Problem/Failure Report
PIND	Particle Impact Noise Detection
PDR	Preliminary Design Review
PER	Pre-environmental Review
PMP	Payload Mounting Plate
PPL	Preferred Parts List
PSR	Pre-shipment Review
QA	Quality Assurance
RE	Radiated Emission
RH	Relative Humidity
RS	Radiated Susceptibility
SAR	Safety Assessment Report
SMAP	Software Management and Assurance Program
SOR	System Operations Review
SSF	Space Station Freedom
SSIP	System Safety Implementation Plan
STS	Space Transportation System
SWCDR	Software Critical Design Review
SWPDR	Software Preliminary Design Review
TIROS	Television Infrared Observation Satellite
TML	Total Mass Loss
TO	Technical Officer
TQCM	Temperature Controlled Quartz Crystal Microbalance
UIID	Unique Instrument Interface Document
WR	Western Range
WRR	Western Range Regulation

APPENDIX B - ABBREVIATIONS, ACRONYMS, AND GLOSSARY (cont'd)

Glossary

Acceptance Tests: The process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies and normally to provide the basis for delivery of an item under terms of a contract.

Assembly: See Hardware: Hardware Levels of Assembly.

Audit: A review of the contractor's or subcontractor's documentation or hardware to verify that it complies with project requirements.

Catastrophic Failure: A failure whose potential effect would result in fatality or serious injury to personnel or loss of the Observatory, the launch facility or vehicle or prevent mission success (loss of a primary mission objective).

Collected Volatile Condensable Material (CVCM): The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific constant temperature for a specified time.

Component: See Hardware: Hardware Levels of Assembly.

Configuration: The functional and physical characteristics of parts, assemblies, equipment of systems, or any combination of these which are capable of fulfilling the fit, form and functional requirements defined by performance specifications and engineering drawings.

Configuration Control: The systematic evaluation, coordination, and formal approval/disapproval of proposed changes and the implementation of all approved changes to the design and production of an item, the configuration of which has been formally approved by the contractor or by the purchaser, or both.

Configuration Management: The systematic control and evaluation of all changes to baseline documentation and subsequent changes to that documentation which define the original scope of effort to be accomplished (contract and reference documentation) and the systematic control, identification, status accounting and verification of all configuration items.

Critical Failure: A failure whose potential effect would result in a significant (as determined by the Project) degradation of a primary mission objective or loss of a secondary mission objective.

Critical Application: Critical applications are defined as part applications in circuits or assemblies whose failure, without

regard to redundancy, would be critical or catastrophic to the mission.

Derating: The reduction of the rating of a device to improve reliability.

Design Specification: Generic designation for a specification which describes functional and physical requirements for an article, usually at the component level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects the end-item specifications serve all the purposes of design specifications for the contract end items. Design specifications provide the basis for technical and engineering management control.

Designated Representative: An individual (such as a NASA plant representative), firm (such as assessment contractor), Department of Defense (DOD) plant representative, or other Government representative designated and authorized by NASA to perform a specific function for NASA. As related to the contractor's effort, this may include evaluation, assessment, design review participation, and review/approval of certain documents or actions.

Destructive Physical Analysis (DPA): An internal destructive examination of a finished part or device to assess design, workmanship, assembly, and any other processing associated with fabrication of the part.

Deviation: A specific written authorization granted prior to the manufacture of an item to depart from a particular or design requirement of a specification, drawing or other document for a specific number of units or a specific period of time.

Discrepancy: See Nonconformance.

Effectivity: The point (in configuration evolution) at which a change or action becomes applicable to the hardware or software.

Electromagnetic Compatibility: The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI): Electromagnetic energy which interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility: Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

End-to-End Tests: Tests performed on the integrated ground and flight system, including all elements of the payload, its control, communications, and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.

Failure: See Nonconformance.

Failure Modes and Effects Analysis (FMEA): Study of a system and working interrelationships of its elements to determine ways in which failures can occur (failure modes), effects of each potential failure on the system element in which it occurs and on other system elements, and the probable overall consequences of each failure mode on the success of the system's mission. Criticalities are usually assigned by categories, each category being defined in terms of a specified degree of loss of mission objectives or degradation of crew safety.

Functional Tests: The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.

Hardware: Physical items of equipment. As used in this document, there are two major categories of hardware as follows:

1. Nonflight Hardware: Development hardware not intended to fly, hardware of flight design but found to be of unsuitable quality for flight use, or hardware intended or use on the ground (e.g., GSE).
2. Flight Hardware: Hardware to be used operationally in space. It includes flight instruments (experiments) and/or spacecraft hardware. It includes the following subsets:
 - a. Qualification Hardware: Hardware of a new design that is subjected to qualification levels and durations of environmental stresses in a design qualification test program; it is identical to the flight hardware, but is not suitable for flight use without acceptable refurbishment.
 - b. Protoflight Hardware: Flight hardware of a new design; it is subject to a design qualification test program employing qualification level environmental stresses for flight durations. It is suitable for flight use after test.
 - c. Follow-On Hardware: Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is subject to a flight acceptance test program.

- d. **Spare Hardware:** Hardware the design of which has been proven in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.

3. Hardware Levels of Assembly

Part: A hardware element that is not normally subject to further subdivision or disassembly without destruction of designed use.

Subassembly: A Subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

Assembly: A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power amplifier and a gyroscope.

Component: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are transmitter, gyro package, actuator, motor, battery. Examples in an instrument are power supply, travelling wave tube amplifier (TWTA), central processing unit (CPU), position encoder, sun sensor, star tracker.

Subsystem: A functional subdivision of a spacecraft or payload consisting of two or more components. Examples are attitude control, electrical power subsystems, or an analogous functional element in an instrument: e.g., subsystems for electrical power, instrument data processing, scanning, or pointing.

System: A functionally interrelated group of hardware and software items which collectively perform one or more defined overall task(s). The system is usually broken down into a number of subsystems, each of which performs a discrete portion of the overall system task(s). E.g., at the instrument level, the defined task is the instrument's flight mission, and the flight instrument is the system; at the spacecraft, the defined task is the flight mission, and the spacecraft is the system, while a flight instrument on the spacecraft is a subsystem.

Instrument: A system or subsystem consisting of sensors and associated hardware for making measurements or observations in space. The flying portion of a flight experiment.

Spacecraft: An integrated assemblage of subsystems designed to perform a specified mission in space.

Payload: An integrated assemblage of subsystems designed to perform a specified mission in space.

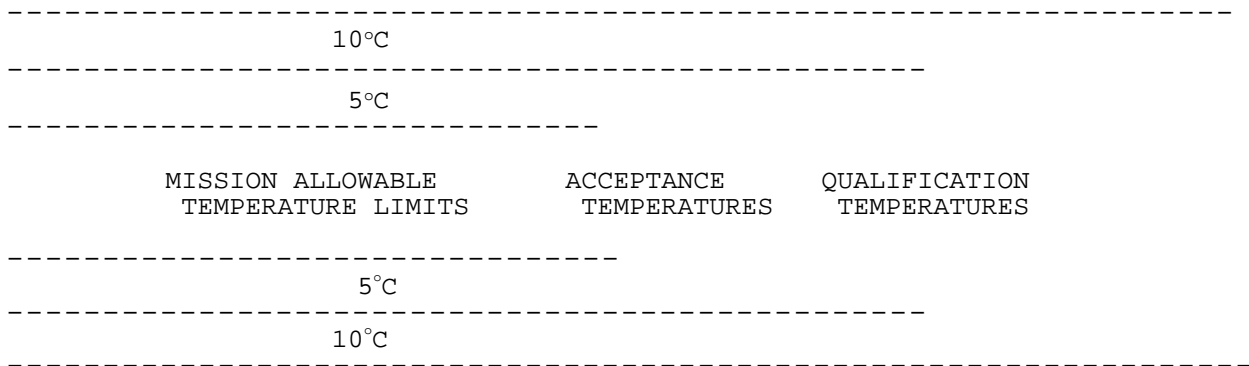
Inspection: The process of measuring, examining, gaging, or otherwise comparing an article or service with specified requirements.

Instrument: See Hardware: Hardware Levels of Assembly.

Margin: The amount by which hardware capability exceeds requirements.

Mission Allowable Temperatures - The mission allowable temperature limits shall encompass those temperatures experienced during the mission and during system-level thermal balance testing.

The relationship between mission allowable, acceptance, and qualification temperatures is as follows:



Model. Generic term to describe a physical or mathematical simulation of an article of hardware, software, or part or all of a mission system. To be useful for purposes of this document, the term must be further identified as to the nature of the model and its purpose. Two examples are:

1. Thermal Model. Unless identified to the contrary by context, this term describes a hardware model. A Thermal Model is a unit of hardware thermally equivalent to a Flight Unit, but need not be capable of the optical, electrical functions or structural/mechanical survivability of a Flight Unit.
2. Thermal Math Model: This may also be called an "analytical thermal model" and is defined as an analytical model used to evaluate the thermal performance of an article of the flight hardware, such as the flight instrument.

A reduced node version of this model is used to evaluate the instrument-spacecraft combination. These models shall be refined after comparison with thermal test data.

Monitor: To keep track of the progress of a performance assurance activity; the monitor need not be present at the scene during the entire course of the activity, but he will review resulting data or other associated documentation (see Witness).

Nonconformance: A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality assurance, nonconformances fall into two categories-- discrepancies and failures. A discrepancy is a departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating. A failure is a departure from specification that is discovered in the functioning or operation of the hardware or software.

Outgassing: The emanation of volatile materials under vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces.

Part: See Hardware: Hardware Levels of Assembly.

Payload: See Hardware: Hardware Levels of Assembly.

Performance Verification: Determination by test, analysis, or a combination of the two that the payload element can operate as intended in a particular mission; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for flight operations.

Platform: See Hardware: Hardware Levels of Assembly: Spacecraft.

Qualification: The process of demonstrating that a given design and manufacturing approach will produce hardware that will meet all performance specifications when subjected to defined conditions more severe than those expected to occur during its intended use.

Redundancy (of design): The use of more than one independent means of accomplishing a given function.

Repair: The article is to be modified by an established (customer approved, where required) standard repair procedure or specific repair instructions which are designed to make the article suitable for use, but which will result in a departure from the original specification.

Rework: Return for completion of operations (complete to drawing). The article is to be reprocessed to conform to the original specifications or drawings.

Similarity, Verification By: A procedure of comparing an item to a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design differences are insignificant, environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.

Single Point Failure: A single element of hardware the failure of which would result in loss of mission objectives or the hardware, as defined for the specific application or project for which a single point failure analysis is performed.

Spacecraft: See Hardware: Hardware Levels of Assembly.

Subassembly: See Hardware: Hardware Levels of Assembly.

Subsystem: See Hardware: Hardware Levels of Assembly.

Temperature Cycle: A transition from some initial temperature condition to temperature stabilization at one extreme and then to temperature stabilization at the opposite extreme and returning to the initial temperature condition.

Temperature Stabilization: The condition that exists when the rate of change of temperatures has decreased to the point where the test item may be expected to remain within the specified test tolerance for the necessary duration or where further change is considered acceptable.

Thermal Balance Test: A test conducted to verify the adequacy of the thermal design and the capability of the thermal control system to maintain thermal conditions within established mission limits.

Thermal-Vacuum Test: A test to demonstrate the validity of the design in meeting functional goals. It also demonstrates the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test can also uncover latent defects in design, parts, and workmanship.

Total Mass Loss (TML): Total mass of material outgassed from a specimen that is maintained at a specified constant temperature and operating pressure for a specified time.

Verification: See Performance Verification.

Vibroacoustics: An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration excitation.

Waiver: A written authorization to accept a configuration item

or other designated item(s), which during production or after being submitted for inspection, are found to depart from specified requirements, but nevertheless are considered suitable for use "as is" or after rework by an approved method.

Witness: A personal, on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements. (see Monitor).

APPENDIX C
EOS UNIQUE REQUIREMENTS

APPENDIX C

The following tailored requirements are specific to EOS developed hardware and software only. For Metsat unique requirements see Appendix D.

**APPENDIX C / SECTION 1
GENERAL REQUIREMENTS**

No tailored requirements

APPENDIX C / SECTION 2

ASSURANCE REVIEW REQUIREMENTS

The following additional review requirements supplement the EOS mission.

2.3 GSFC FLIGHT ASSURANCE REVIEW PROGRAM

For instrument-level reviews, the review material shall deal with all aspects of the instrument and its functions. For the EOS Observatory-level reviews, the material and presentations shall be of a degree of detail appropriate to the support of the review at this level. The contractor shall provide support pertinent to the contractors instrument for the Observatory level reviews.

Review of the Observatory will include an Observatory level MOR, PER, PSR, FOR, and FRR; these shall include information on the instruments provided by the contractor sufficient detail to facilitate understanding of their relationship to the flight segment and mission. The MOR, FOR and FRR are described as follows:

Mission Operations Review (MOR) This mission-oriented review will normally take place prior to significant integration of the flight system. The purpose is to review the status of the system components, including the ground system and its operational interfaces with the flight system. Discussions will include integration and test planning.

Flight Operations Review (FOR) While all of the previous reviews involve operations, this review will emphasize the final orbital operations plans, as well as the compatibility of the Observatory with ground support equipment and ground network, including summary results of the network compatibility tests.

Flight Readiness Review (FRR) This review is to assess the overall readiness of the total system to support the flight objectives of the mission.

APPENDIX C / SECTION 3 PERFORMANCE VERIFICATION REQUIREMENTS

3. Performance Verification Requirements

3.1 General Requirements (Mod 25)

Methods for implementing the requirements of this section are contained in the ELV payload requirements of the General Environmental Verification Specification for STS and ELV Payloads, Subsystems, and Components ("GEVS-SE") (Appendix A of the PAR).

The GEVS-SE establishes the general environmental test requirements for the instrument. Unique requirements for the instruments and components will be provided in the General Interface Requirements Document (GIRD) for the spacecraft and the respective unique instrument interface documents (UIIDs) and interface control documents (ICDs). These will be updated if necessary when the dynamic model of the spacecraft has been verified by test.

The instrument-level vibroacoustics test required by this section shall be conducted with the inputs at the instrument mounting interface. Tests of the instrument mounting plates and other instrument flight support equipment shall be conducted as a part of spacecraft testing. The GIRD requirements for shock (Section 10.4) are not applicable.

3.2.1 VERIFICATION PLAN

As an adjunct to the Verification Plan, a verification matrix (see par. 1.10.1.1 of GEVS-SE) shall be prepared that summarizes all tests and analyses that will be performed on each component, subsystem, and the instrument. The contractor shall also maintain a matrix of contractor/subcontractor tests actually accomplished throughout the program and present it at the pertinent GSFC reviews called for in section 2.

3.2.2 VERIFICATION SPECIFICATION

A Verification Specification shall be prepared that stipulates the specific environmental parameters associated with each of the tests and analyses required by the Verification Plan. This specification may be combined with the Verification Plan. In defining quantitative environmental parameters under which the hardware elements must meet their performance requirements, the Verification Specification shall consider things such as payload peculiarities and pertinent requirements of the respective project's spacecraft GIRD and the respective individual instrument UIID and ICDs.

The Verification Specification shall be delivered to GSFC and updated in accordance with GSFC-422-12-12-04 Contract Documentation Requirements List (CDRL).

3.4 STRUCTURAL AND MECHANICAL REQUIREMENTS

3.4.1 GENERAL REQUIREMENTS

The contractor shall demonstrate compliance with structural and mechanical requirements with a series of interdependent test and analysis activities. The baseline requirements are stated in the General Interface Requirements Document (GIRD) for the spacecraft and the instrument UIID and ICDs; they will be updated, based on the results of modal survey of the EOS Observatory and the designated location of the instrument.

The demonstrations shall verify design and specified factors of safety, ensure interface compatibility with the EOS Observatory, acceptable workmanship, and compliance with associated systems safety requirements. In the event that modal survey of the spacecraft shows the baseline environments for any instrument to be inadequate, verification and/or design modifications may be required.

3.4.2 REQUIREMENTS SUMMARY

Table 3-1 (Appendix C) specifies the structural and mechanical verification activities for EOS.

3.4.3 STRUCTURAL LOADS

3.4.3.1 Verification for Design Qualification.

An analysis shall be performed to ascertain the resonant frequencies of the instrument's fixed base modes. Where the analysis clearly shows the fundamental frequency to be above 100 Hz, verification by test is not required.

For instrument structures whose analysis indicates a resonant frequency below 100 Hz, a sine sweep shall be performed to determine the fundamental resonant frequency. Where this is found to be below 70 Hz, a modal survey shall be performed to verify that the analytic model of the Instrument hardware adequately represents its dynamic characteristics. Test verification for instruments with fundamental fixed-base modes above 70 Hz may be limited to the frequency verification test (low level sine sweep). Instruments with fundamental fixed-base modes above 100 Hz shall supply an analytical rigid mass representation.

The test-verified model will be used in a coupled loads analysis at the spacecraft level to predict for the instrument the maximum expected load for each potentially critical loading condition, including all launch environments, handling and transportation, and vibroacoustic effects during lift-off. The maximum loads resulting from the analysis define the limit loads.

The usual method of verifying adequate strength is to apply a set of loads equal to 1.25 times the limit loads after which the instrument hardware must be capable of meeting its performance criteria. Standard design criteria require that the strength verification test be accompanied by a stress analysis that predicts that no ultimate failure will occur at loads equal to 1.40 times limit and that yielding will not occur at loads equal to 1.25 times limit.

If appropriate development tests are performed to verify accuracy of the stress model, and stringent quality control procedures are invoked to ensure conformance of the structure to the design, then strength verification may be accomplished by a stress analysis that demonstrates that the hardware has positive margins on yield at loads equal to 2.0 times the limit load, and positive margin on ultimate at loads equal to 2.6 times the limit load. Analysis shall not be used to verify strength of elements fabricated from composite materials. The wider range of strength associated with composite structures must be taken into account by additional demonstrations such as development tests, proof tests and larger design factors.

The contractor shall analyze all flight structures as well as all test structures that are subjected to the flight hardware test environments. The analyses shall utilize design limit loads predicted for all flight and testing environments and shall include all required factors of safety. The analysis shall be performed in accordance with commonly accepted methods and assumptions and culminate with a set of Margins of Safety (M.S.) equations. Buckling, crippling, and shear failures shall be considered as ultimate failures.

The stress report shall be delivered in accordance with GSFC-422-12-12-04 (CDRL). The analysis shall be updated when the test-verified model is delivered. As a minimum, it shall contain the following:

- a. Stress analysis results for current design limit loads, with yield and ultimate factors applied as specified above.
- b. Comprehensive M.S. Summary for all load cases.

The initial stress assignment shall be based on the preliminary design loads. The contractor shall keep the M.S. Summary updated as the design of the structure changes, mathematical models are refined, and/or new loads analyses are performed.

The use of materials that are susceptible to brittle fracture or stress-corrosion cracking require development of, and strict adherence to special procedures to prevent problems. It is emphasized that all structural elements shall be in compliance with the provisions of Section 4.3 of the PAR.

Table 3-1 Structural and Mechanical
Verification Requirements (Mod 25)

Requirement	Observatory*	Instrument	Component**
Structural Loads			
Modal Survey	A/T	A/T	-
Loads Test			
- Design Qual.	A/T	T	-
- Struct. Rel.	A/T	A/T	A/T
Vibroacoustics			
- Acoustics	T	T1	T1
- Random Vibration	-	T	T1
Sine Vibration	T3	T3	T3
Mechanical Function	A, T	T	-
Pressure Profile	-	A, T1	-
Mass Properties	A, T1	A/T	-

T = Test required

T1 = Test must be performed if indicated by analysis or other considerations.

T2 = Separate additional test at component level is normally required, but may be waived in special cases, such as for small instruments.

T3 = Test if there is any sustained periodic mission environment. Test is a sweep per GEVS-SE, Table A-1.

A = Analysis required.

A/T = Analysis and/or test

* = Observatory requirements apply when instrument is integrated. (Observatory testing is responsibility of integration contractor.)

** = Requirements for components (boxes) of the instruments.

3.4.3.2 Acceptance Requirements. Structural loads testing to limit levels is required for all flight hardware (see par. 4.3).

3.4.4 VIBROACOUSTICS

3.4.4.1 Verification for Design Qualification. For the vibroacoustics environments, limit levels are equal to the maximum expected flight environment. The verification level is defined as the limit plus 3 dB. When random vibration levels are determined, responses to the acoustic inputs plus the effects of vibration transmitted through the structure shall be considered. As a minimum, component random vibration levels shall be sufficient to demonstrate acceptable workmanship. For qualification of hardware, tests shall be conducted at verification (protoflight) levels.

3.4.4.4 Acceptance Requirements. Structural loads testing to limit levels is required for all flight hardware (see par. 4.3).

3.4.6 MECHANICAL FUNCTION

3.4.6.1 Verification for Design Qualification. A kinematic analysis of all instrument mechanical operations is required (a) to ensure that each mechanism can perform satisfactorily and has adequate margins under worst-case conditions, (b) to ensure that satisfactory clearances exist for both the stowed and operational configurations as well as during any mechanical operation and (c) to ensure that all mechanical elements are capable of withstanding the worst-case loads that may be encountered. In addition, instrument verification tests are required to demonstrate that the installation of each mechanical device is correct and that no problems exist that will prevent proper operation of the mechanism during mission life.

Instrument verification tests are required for each mechanical operation at nominal, low, and high energy levels. To establish that functioning is proper for normal operations, the nominal test shall be conducted at the most probable conditions expected during normal flight. A high-energy test and a low-energy test, shall also be conducted to prove positive margins of strength and function. The levels of these tests shall demonstrate margins beyond the nominal conditions by considering adverse interaction of potential extremes of parameters such as temperature, friction, spring forces, stiffness of electrical cabling or thermal insulation, and, when applicable, spin rate. Parameters to be varied during these high- and low-energy tests shall include, to the maximum extent practicable, all those that could substantively affect the operation of the mechanism, as determined by the results of analytic predictions or development tests. As a minimum, however, successful operation at temperature extremes 10 degrees C beyond the range of expected flight temperatures shall be demonstrated.

3.4.6.2 Acceptance Requirements. Verification testing of instrument mechanical operation is required only at the nominal condition for the acceptance of previously qualified hardware if the original basis for qualification is still valid for the new application.

3.4.9 SINE VIBRATION

3.4.9.1 Verification for Design Qualification. The hardware shall be subjected to sine vibration testing for the sweep rate indicated in Table A-1 of GEVS-SE to 1.25 times flight levels on axes representative of the mission to qualify the hardware for any sustained periodic mission environment.

3.4.9.2 Acceptance Requirements. The acceptance testing of previously qualified hardware shall include subjecting the hardware to sine vibration testing for the sweep rate indicated in Table-A-1 of GEVS-SE to expected flight levels on axes representative of the mission to simulate any sustained periodic mission environment.

3.5.2 REQUIREMENTS SUMMARY

3.5.2.1 The Range of Requirements. The contractor shall demonstrate compliance with the general requirements of paragraph 3.5.1 by conducting an EMC test program in accordance with Table 3-2 and Section 2.5 of GEVS-SE and the Observatory EMI/EMC Control Plan. Table 3-2 Appendix C prescribes tests at the component and instrument levels. Not all tests apply to all levels of assembly or to all types of hardware.

Table 3-2 EMC Requirements per Level of Assembly

Type	Test	GEVS-SE Para. #	Component	Instrument	Observatory (*)
CE	DC power leads	2.5.2.1a 2.5.2.1b	R R	R R	- -
CE	Antenna terminals	2.5.2.1e	R	-	-
RE	AC magnetic fields	2.5.2.2b	R	R	R
RE	E-fields	2.5.2.2c 2.5.2.2d	R R	R R	R R
RE	Payload xmitters	2.5.2.2e	-	-	**
RE	Spurious (xmitter antenna)	2.5.2.2f	-	R	-
CS	Pwr lines	2.5.3.1a	R	R	-
CS	Pwr line transients	2.5.3.1e	R	R	-
CS	Inter-modulation products	2.5.3.1b	R	-	-
CS	Signal Rejection	2.5.3.1c	R	-	-
CS	Cross modulation	2.5.3.1d	R	-	-
RS	E-field (general)	2.5.3.2a	R	R	R
RS	Magnetic field susceptibility	2.5.3.2d	R	R	R
	Magnetic properties	2.5.4	R	R	R

Table 3-2 EMC Requirements per Level of Assembly (continued)

CE - Conducted Emission; CS - Conducted Susceptibility.

R - Test to ensure reliable operation of hardware, and to help ensure compatibility with the ELV and launch site.

RE - Radiated Emission; RS - Radiated Susceptibility.

* - Observatory requirements apply when instrument is integrated;
Test is Observatory contractor responsibility.

** - Must meet any unique requirements of the ELV and launch site for transmitters that are on during launch.

3.5.2.2 Basis of the Tests. A description of the individual EMC tests listed in table 3-2, including their nominal limits and test procedures, is provided in section 2.5 of the GEVS-SE. Most of the tests are based on the requirements of MIL-STD-462, MIL-STD-461 and MIL-STD-463. The specific limits (levels) shall be as defined in the Observatory EMI/EMC Control Plan. The tests and their limits may be revised as appropriate for a particular instrument or mission if GSFC project approval is obtained. More stringent requirements may be necessary. The tests and their limits shall be documented in the Verification Specification (3.2.2 Appendix C).

Additional EMC requirements may also be placed on the Observatory by the launch vehicle organization or as a result of the launch site radiation environment; these requirements will be established during coordination between the EOS Project and the cognizant launch vehicle/site organizations. Corresponding flow-down of such additional requirements to the instrument will be negotiated similarly between the EOS Instrument Project Office and the contractor.

3.6.2 SUMMARY OF REQUIREMENTS

Table 3-3 (Appendix C) summarizes the tests and analyses that collectively will serve to fulfill the general requirements of (3.6.1 PAR). Tests noted in the table may require supporting analyses and vice versa. The order in which demonstrations are conducted shall be determined by the contractor and specified in the Verification Plan (3.2.1 Appendix C).

Table 3-3 Vacuum, Thermal, and Humidity Requirements

Requirement	Spacecraft*	Instrument/ Component
Thermal-Vacuum	T	T1
Thermal Balance	T/A	**
Temperature-humidity (integration and checkout with ELV)	A	A ***
Temperature-Humidity (Transportation & Storage)	A	A ***
Leakage(1)	T3	T2

(1) = Hardware that passes this test at a lower level of assembly need not be retested at a higher level unless there is reason to suspect its integrity.

T = Test required.

A = Analysis required; tests may be required to substantiate the analysis.

T/A = Test is highly desirable, however an analysis is mandatory.

* = spacecraft requirements apply when instrument is integrated. (Spacecraft testing is the responsibility of the integration contractor.)

** = Test required at instrument level, but not at component (box) level unless otherwise specified.

*** = Requirement pertains to instrument level; not component.

T1 = Test required at instrument level. Additional cycles at component level required if needed for components to see a total of 8 T-V temperature cycles before shipment of the instrument.

T2 = Test required for sealed items only, at component level or instrument level.

T3 = Test required for sealed items only.

3.6.3 THERMAL CYCLE (Mod 47)

3.6.3.1 Ambient Pressure Thermal Cycling. Thermal stress testing shall be performed at ambient pressure as shown in figure C1. The testing shall consist of eight cycles with a maximum temperature of 48C (-0C, +3C), as measured at the coldest monitored point of the instrument, and a minimum temperature of -12C (+0C, -3C), as measured at the hottest monitored point of the instrument. A performance verification test shall be performed at each maxima and minima plateau. The minimum time at each plateau shall be that which is needed to execute the performance verification test. During the first transition to the minima plateau, the instrument shall be shut off and an instrument "cold start" test shall be performed when the instrument reaches the minima plateau. During transition to the minima plateau during all other cycles, the instrument may be shut off. The maximum temperature rate change during the transition states shall be 12°C/hour. During the ambient pressure cycling the instrument's blanket may be removed.

Outgassing procedures that are found necessary (see Section 9.0) may be made part of the thermal-vacuum test operations if no unacceptable hazards are introduced by these procedures.

3.6.3.2 Vacuum Thermal Cycling. The instrument shall be subjected to a thermal vacuum test where the pressure is 1×10^{-5} Torr or less and the test profile is shown in Figure C2. The unit shall be in the launch phase mode for pump down.

During transition to the "Projected Low -10C" (minima) plateau, the instrument shall be shut off.

After the minimum 4 hour soak at the minima plateau, an instrument "cold start" and a performance verification test shall be performed. After the minimum 4 hour soak at the "Projected High +10°C" plateaux, an instrument performance verification test shall be performed. Concurrent with the 48 hour instrument operational temperature soaks, instrument calibration shall be performed.

During temperature transition the rate of change in temperature shall not exceed 10C/hour or be less than 5C/hour. Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration purposes (e.g., A/D, etc). The control of the test for conformance to the specifications shall be based on the thermal instrumentation of the maximum and minimum structural areas. This instrumentation shall not invalidate the true nature of the thermal environment being measured.

In planning and conducting the test, care should be exercised so that unrealistic internal gradients are not generated which could jeopardize the integrity of the instrument.

Figure C1 Thermal Cycle Profile (Mod 47)

Figure C2 Thermal Vacuum Test Profile (Mod 47)

3.7 END-TO-END TEST REQUIREMENTS

3.7.1 COMPATIBILITY TEST

System end-to-end testing of the instrument at the spacecraft level is the responsibility of the spacecraft contractor. The instrument contractor shall support this test effort as it applies to the instrument integrated with the spacecraft.

3.7.2 Mission Simulations. After completion of the end-to-end compatibility test, data flow tests (at spacecraft level) shall be performed utilizing the total system in a realistic mission timeline, including external stimulus of the instruments and attitude control sensors, when practical.

Telemetry and command demonstrations shall be conducted, incorporating all the required equipment: appropriate Network elements, Ecom, EOS Operations Center (EOC), Instrument Control Facility (ICF), data processing facilities, and when available, the users' Instrument Support Terminal. Once the data flow paths have been verified, mission simulations will be held to validate nominal and contingency mission procedures and to provide for operator familiarization training. The contractor shall participate in mission simulations in order to provide ample time for checkout of the contractors EOC software and hardware configurations.

**APPENDIX C / SECTION 4
SYSTEM SAFETY REQUIREMENTS**

No tailored requirements

APPENDIX C / SECTION 5
EEE PARTS CONTROL REQUIREMENTS

5.2.4 RADIATION HARDNESS

In addition, standard and nonstandard parts shall be selected to meet their mission application in the predicted radiation environment as defined in the General Interface Requirements Document (GIRD) for the spacecraft.

APPENDIX C / SECTION 6
MATERIALS AND PROCESSES CONTROL REQUIREMENTS

No tailored requirements.

APPENDIX C / SECTION 7
DESIGN ASSURANCE AND RELIABILITY REQUIREMENTS

No tailored requirements.

APPENDIX C / SECTION 8
QUALITY ASSURANCE REQUIREMENTS

No tailored requirements

**APPENDIX C / SECTION 9
CONTAMINATION CONTROL REQUIREMENTS**

9.3 INSTRUMENT CROSS-CONTAMINATION

Since the spacecraft will contain many instruments with widely varying contamination sensitivities in close proximity to each other, the instruments could contaminate each other, thus jeopardizing each others' performance. In order to minimize this, each instrument, regardless of its contamination sensitivity, must meet the following minimum cleanliness requirements.

The external surfaces of all instruments shall be at Level 600A or better (per MIL-STD-1246) upon delivery to the integration contractor. Surface cleanliness levels shall be verified upon delivery to the spacecraft contractor.

At the last hot cycle of the instrument-level thermal-vacuum testing, all instruments shall outgas at a rate less than or equal to 1×10^{-7} grams/square centimeter/hour for 5 consecutive hours at the maximum instrument operating temperature, as measured by a temperature-controlled quartz crystal microbalance (TQCM) located within the test chamber and maintained at -20 ± 2 degrees C. The TQCM must have a representative view of the instrument.

**APPENDIX C / SECTION 10
SOFTWARE ASSURANCE REQUIREMENTS**

No tailored requirements

APPENDIX D

METSAT UNIQUE REQUIREMENTS

APPENDIX D

The following tailored requirements are specific to Metsat developed hardware and software only. For EOS unique requirements see Appendix C

APPENDIX D / SECTION 1
GENERAL REQUIREMENTS

No tailored requirements.

**APPENDIX D / SECTION 2
ASSURANCE REVIEW REQUIREMENTS**

The following additional review requirements supplement the Metsat Program.

2.3 GSFC FLIGHT ASSURANCE REVIEW PROGRAM

- a. Preliminary Design Review. In addition, the PDR review shall consist of the review of design and all additional changes that have to be made.

APPENDIX D / SECTION 3 PERFORMANCE VERIFICATION REQUIREMENTS

3. PERFORMANCE VERIFICATION REQUIREMENTS

3.1 General Requirements

Environmental specifications for this instrument are contained in Appendix E. The requirements contained therein include levels required for shuttle and expendable launch vehicles. A total Performance Verification Program requires the demonstration and verification of supporting components and equipment, such as flight software and ground-test hardware and software. It may also include the demonstration of interfaces to networks and control centers. Verification of these items may be included in a single Performance Verification Program.

3.4 STRUCTURAL AND MECHANICAL REQUIREMENTS

3.4.1 GENERAL REQUIREMENTS

The demonstrations shall verify design and specified factors of safety and ensure interface compatibility, acceptable workmanship, and compliance with applicable safety requirements.

3.4.2 REQUIREMENTS SUMMARY

Table 1 (Appendix D) specifies the structural and mechanical verification activities for Metsat.

The program outlined in table 1 assumes that the design of the instrument (including the electronics package) mount to the spacecraft as a single entity and can therefore be environmentally tested together. When that is not the case, each element of the instrument that mounts directly to the spacecraft shall be subjected to the "instrument" test requirements of Table 1.

3.4.3 STRUCTURAL LOADS

3.4.3.1 Verification for Design Qualification.

In addition, the following verification elements apply to Metsat:

A vibration survey shall be conducted to verify that the lowest resonant frequency of the instrument is equal to or greater than 100 Hz.

The usual method of verifying adequate strength is to apply a set of acceleration and sinusoidal vibration loads to the qualification levels of section 1 and 2 of Appendix E after which the hardware must be capable of meeting its performance criteria. If appropriate development tests are performed to verify accuracy of the stress model and stringent quality-control procedures are invoked to ensure

conformance of the structure to the design, the strength verification for the acceleration loads may be accomplished by a stress analysis which demonstrates that the hardware will meet its performance and safety criteria after being subjected to a load equal to 1.6 times the qualification test loads of section 1 of Appendix E. The sinusoidal vibration test must still be performed, however.

When composite materials are used in the structure, analytic strength verification for acceleration loads may not be in used. The wider ranges of strength associated with composite structures must be taken into account by additional demonstrations, such as development tests, proof tests, and larger design factors. The use of materials that are susceptible to brittle fracture or stress-corrosion cracking require the development of and strict adherence to special procedures to prevent problems.

Table 1 Structural and Mechanical Requirements

Requirement	Instrument	Component
Structural Loads	T	-
Vibroacoustics		
- Acoustics	T1	-
- Random Vibration	T	T
Mechanical Shock	T	-
Mechanical Function	T	-
Pressure Profile	A, T1	-
Mass Properties	A, T1	-

T = Test required

T1 = Test must be performed if indicated by analysis or other considerations.

T2 = Separate additional test at component level is normally required, but may be waived in special cases, such as for small instruments.

A = Analysis required.

3.4.3.2 Acceptance Requirements. The flight sinusoidal vibration test requirements of section 1 of Appendix E apply for the acceptance testing of previously qualified hardware. In addition, structural elements fabricated of composite material shall be proof-tested to 80% of the qualification test levels of section 1 of Appendix E.

3.4.4 VIBROACOUSTICS

In addition, the following vibroacoustics criteria apply to Metsat:

3.4.4.2 Random Verification. The verification instrument random vibration test shall be applied in each of the three orthogonal axes to the qualification levels of section 1 of Appendix E. In addition, components shall be subjected to a three-axis random vibration exposure prior to instrument integration. The level for the component tests shall be either:

- 1) that expected at the component mounting location during instrument test, or;
- 2) the instrument levels, whichever is greatest.

3.4.4.3 Acoustics Verification. The spacecraft with its payload, as part of its environmental testing sequence, will be exposed to an acoustic test shown in section 1 of Appendix E. The contractor shall review his instrument for large area/low mass components that would be exposed to, and could be affected by, direct acoustic energy. Such instruments may require an acoustic test in addition to the random test to ensure proper operation during and after the launch phase.

3.4.4.4 Acceptance Requirements. For the acceptance testing of previously qualified hardware, testing shall be conducted on the instrument at the flight levels of section 2 of Appendix E. Random vibration tests shall also be performed on components. Levels shall be determined in the same manner as for the verification tests. Acoustics test is not required.

3.4.6 MECHANICAL FUNCTION

3.4.6.1 Verification for Design Qualification. Kinematic analysis of mechanical operations shall be conducted to ensure that the instrument performs satisfactory and has adequate margins under worst-case conditions. In addition, testing of bearings, gears, balance mechanisms, etc. used in electromechanical systems shall be accomplished to verify performance and to established baseline parameters of assembly elements prior to assembly testing.

3.4.6.2 Acceptance Requirements. Verification testing of instrument mechanical operation is required only at the nominal condition for the acceptance of previously qualified hardware if the original basis for qualification is still valid for the new application.

3.5.2 REQUIREMENTS SUMMARY

3.5.2.1 The Range of Requirements.

The contractor shall demonstrate compliance with the general requirements of paragraph 3.5.1 (PAR) by conducting an EMC program in accordance with Table 2 Appendix D. Tests are prescribed at the instrument and component levels. Not all tests apply to all levels of assembly or to all types of hardware. The contractor shall select the applicable EMC tests on the basis of mission requirements and the specific requirements of the hardware. The specific requirements of each test listed in table 2 are defined in Appendix D.

The contractor shall impose more stringent requirements than those in Appendix D when necessary to meet the specific requirements of the mission. For example for an instrument with very sensitive electric field or magnetic field requirements may require more stringent test limits.

Table 2 EMC Requirements

Type of Test	Description	Level of Assembly	
		Instrument	Component
Emissions	Conducted (powerlines)	R	R
	Radiated E-field (unintentional)	R	R
	Radiated H-field (ac)	R	R
Susceptibility	Conducted (dc powerlines)	R	R
	Conducted transient (powerline)	R	R
	Radiated E-field	R	R
Magnetics	Magnetic Properties	R	R

R - Test to ensure reliable operation of spacecraft

3.6.3 THERMAL-VACUUM

3.6.3.1 General Requirements (Mod 25). The protoflight instrument shall be subjected to a thermal vacuum test in which the pressure is 1×10^{-5} torr or less. The test temperature profile is shown in figure 2 of Appendix E. The unit shall be in the launch phase mode for pump down and in the mission mode for all other phases of the test. The temperature extremes shall be 10 degrees C more severe than those worst-case temperatures expected during orbital conditions.

During temperature transitions, the rate of change in temperature shall not exceed 10 degree C/hour or be less than 2 degrees C/hour.

The flight instrument shall be subjected to a thermal - vacuum test in which the pressure is 1×10^{-5} torr or less. The test profile is shown in figure 3A of Appendix E, and the unit shall be operational for all phases of this test. The temperature extremes shall be those worse-case temperatures expected during orbital conditions as determined by analysis and the thermal balance test of the engineering model. During the test, the hottest and coldest parts of the instrument structure shall be driven to the temperatures determined to be appropriate based on the requirements stated previously.

Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration purposed. The control of the test for conformance to the specification shall be based on the thermal instrumentation of the baseplate. This instrumentation shall not invalidate the true nature of the thermal environment being measured.

In planning and conducting the test, care should be exercised so that unrealistic internal gradients are not generated that could jeopardize the integrity of the instrument.

Specific performance tests that shall be performed during the thermal-vacuum test cycle are defined subsequently.

**APPENDIX D / SECTION 4
SYSTEM SAFETY REQUIREMENTS**

No tailored requirements

APPENDIX D / SECTION 5
EEE PARTS CONTROL REQUIREMENTS

No tailored requirements

APPENDIX D / SECTION 6
MATERIALS AND PROCESSES CONTROL REQUIREMENTS

No tailored requirements.

**APPENDIX D / SECTION 7
DESIGN ASSURANCE AND RELIABILITY REQUIREMENTS**

No tailored requirements.

**APPENDIX D / SECTION 8
QUALITY ASSURANCE REQUIREMENTS**

No tailored requirements

**APPENDIX D / SECTION 9
CONTAMINATION CONTROL REQUIREMENTS**

No tailored requirements

**APPENDIX D / SECTION 10
SOFTWARE ASSURANCE REQUIREMENTS**

No tailored requirements.

APPENDIX E

METSAT ENVIRONMENTAL SPECIFICATIONS

APPENDIX E ENVIRONMENTAL SPECIFICATIONS

The following environmental specifications are applicable to the METSAT AMSU-A instruments.

1.0 Engineering and Protoflight Models

The engineering and protoflight models shall be subjected to the following qualification level environmental tests. The unit is to be operated during these tests in a manner simulating actual operation during various flight stages and must meet all specified performance criteria during these tests.

1.1 Sine Sweep Test

Before and after each axis of testing, a sine sweep from 20 to 200 Hz shall be conducted at 4 octaves per minute. A constant sinusoidal input of 0.25g's or less shall be used over the frequency domain. Sufficient instrumentation (external) shall be installed and the data verified after each axis to detect possible structural changes.

1.2 Acceleration Test (Static Load)

A test shall be conducted where 15.0g longitudinal and 6.3g lateral loads shall be applied simultaneously (16.3g) first in the ZX and ZY planes (spacecraft coordinates) for one minute. The test method may be either static load, centrifuge or sine burst (see section 1.1.1). The unit must be in flight configuration. An alternative test is to apply the combined load (16.3g) in the A, Y, Z axes, when the instrument is mounted on the shaker, as it will be on the spacecraft.

Design analysis shall be conducted with the following load levels:

X-axis	± 19.6	Y-axis	± 21.2	Z-axis	± 20.6
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1.2.1 Sine Burst

The sine burst test is used to simulate a static load condition on the test item. The test is performed on a vibration shaker. The frequency used to perform the test is a function of both the dynamic characteristics of the test item and the vibration shaker facility limitations. Because the test is intended to impart a static load to the test item, the test frequency must be below the fundamental resonant frequency of the test item. As a general guideline, the test frequency should be less than one-third the test item resonant frequency to avoid dynamic amplification during the test. The vibration shaker facility limitation is driven by the maximum allowable displacement for the particular shaker.

Figure 1 shows a typical sineburst waveform. The waveform is sinusoidal with a ramp up to maximum level, several cycles at maximum level, and then ramp down to zero. The number of cycles at maximum level is usually 6 to 10 cycles.

Figure 1 Sine Burst

E-2

E-3

The specification of a sine burst test should contain the following information:

- o Test Level = xx.x g
- o Test Frequency = less than 1/3 the fundamental resonant frequency of the test item
- o Test Duration = 6 to 10 cycles at maximum level.

1.3 Random Vibration Tests

The unit shall be subject to the following levels in each of three orthogonal axes:

- Z-Z: Thrust axis, as applicable to unit installed on spacecraft -
- X-X & Y-Y: Perpendicular to Z-Z and defined as the spacecraft X-X and Y-Y axes -

Freq. Power Spectral Range (Hz)	Density (g^2/Hz)	G-RMS	Duration
20-75	0.011		
75-150	+10dB/oct.	8.8	1 min./axis
150-500	0.11		
500-2000	-7db/oct.		

1.4 Launch Phase Pressure Profile

The instrument shall be designed, such that, when subjected to the environment shown in the GIIS, no adverse conditions which may effect performance shall result. An actual test is required if analysis does not indicate a sufficient margin of safety.

1.5 Acoustic Test Requirements

The spacecraft with its payload, as part of its environmental testing sequence, shall be exposed to the acoustic levels shown in the GIIS. During launch, a similar environment is expected inside the shroud. The specified instrument random vibration levels are based upon the above acoustic levels, which are coupled with and conducted through the spacecraft structure and finally mechanically transmitted to the instruments.

However, the contractor should review his instrument for large area/low mass components which would be exposed to and could be effected by direct acoustic energy. Such instruments may require an acoustic test to assure proper operation during and subsequent to the launch phase.

1.6 Thermal Vacuum Qualification Test

The instrument shall be subjected to a thermal vacuum test where the pressure is 1×10^{-5} Torr or less and the test temperature profile is shown in Figure 2 for the Engineering Model.

Figure 2 Thermal Vacuum Test Profile

The unit shall be in the launch phase mode for pump down and in the mission mode for all other phases of this test. For the EM, when the instrument reaches the low plateau, it will be turned off, thermal balance achieved, and a "cold start" turn on performed. The temperature extremes shall be 10°C more severe than those "worst case" temperatures expected during orbital conditions. During temperature transitions the rate of change in temperature shall not exceed 10°C/hour or be less than 5°C/hour.

The Protoflight unit shall have the same level of testing performed as described in section 2.3 for the Flight units. Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration purposes. The control of the test for conformance to the specification shall be based on the thermal instrumentation of the baseplate. This instrumentation shall not invalidate the true nature of the thermal environment being measured.

In planning and conducting the test, care should be exercised so that unrealistic internal gradients are not generated which could jeopardize the integrity of the instrument.

Specific performance tests which shall be performed during the thermal vacuum test cycle are defined subsequently.

1.7 Thermal Balance

This test shall demonstrate the validity of the thermal design and the ability of the thermal control system to maintain the hardware within the established thermal limits for the mission.

The thermal design shall be validated with an analytical model that is confirmed when necessary by tests conducted on a thermal model or the flight hardware. The capability of the thermal control system shall be demonstrated in the same manner. If the flight hardware is not used in the test of the control system, verification of critical thermal properties (such as those of the thermal control coatings) shall be performed to demonstrate similarity between the item tested and the flight hardware. Although it is desirable to perform the test on a complete AMSU, it may be impractical to do so; therefore, the demonstration may be accomplished by combining test and analysis.

1.7.1 Acceptance Requirements

The thermal balance test may be waived in the case of previously qualified hardware. Tests shall be conducted to verify the thermal similarity to the qualified hardware.

1.8 Electromagnetic Compatibility

An Electromagnetic Compatibility test shall be performed in accordance with the GIIS and the UIIS.

2.0 Flight Acceptance Testing

The flight models shall be acceptance tested to the following tests and levels.

2.1 Sine Sweep Test

Before and after each axis of testing, a sine sweep from 20 to 200 Hz shall be conducted at 4 octaves per minute. A constant sinusoidal input of 0.25g's or less shall be used over the frequency domain. Sufficient instrumentation (external) shall be installed and the data verified after each axis to detect possible structural changes.

2.2 Random Vibration

The units shall be subjected to the following acceptance level random vibration in each of three orthogonal axes.

Freq. Range (Hz)	Power Spectral Density (g^2/Hz)	G-RMS	Duration
20-75	0.005		
75-150	+10dB/oct.	5.9	1 min./axis
150-500	0.05		
500-2000	-7db/oct.		

2.3 Acceleration Test (Static Load)

In order to meet the fracture control requirements, a static load test (section 1.1) shall be conducted with 12.0g longitudinal and 5.05g lateral, applied simultaneously (13.02g).

2.4 Thermal Cycle

2.4.1 Ambient Pressure Thermal Cycling

Thermal stress testing shall be performed at ambient pressure as shown in figure 3. The testing shall consist of eight cycles with a maximum temperature of 48C (-0C, +3C), as measured at the coldest monitored point of the instrument, and a minimum temperature of -12C (+0C, -3C), as measured at the hottest monitored point of the instrument.

A performance verification test shall be performed at each maxima and minima plateau. The minimum time at each plateau shall be that which is needed to execute the performance verification test. During the first transition to the minima plateau, the instrument shall be shut off and an instrument "cold start" test shall be performed when the instrument reaches the minima plateau. During transition to the minima plateau during all other cycles, the instrument may be shut off.

The maximum temperature rate change during the transition states shall be 12°C/hour. During the ambient pressure cycling the instrument's blanket may be removed.

2.4.2 Vacuum Thermal Cycling

The instrument shall be subjected to a thermal vacuum test where the pressure is 1×10^{-5} Torr or less and the test profile is shown in Figure 3a. The unit shall be in the launch phase mode for pump down.

During transition to the "Projected Low -10C" (minima) plateau, the instrument shall be shut off.

Figure 3 Thermal Cycle Profile

Figure 3a. Thermal Vacuum Test Profile

After the minimum 4 hour soak at the minima plateau, an instrument "cold start" and a performance verification test shall be performed. After the minimum 4 hour soak at the "Projected High +10°C" plateaux, an instrument performance verification test shall be performed. Concurrent with the 48 hour instrument operational temperature soaks, instrument calibration shall be performed.

During temperature transition the rate of change in temperature shall not exceed 10C/hour or be less than 5C/hour. Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration purposes (e.g., A/D, etc). The control of the test for conformance to the specifications shall be based on the thermal instrumentation of the maximum and minimum structural areas. This instrumentation shall not invalidate the true nature of the thermal environment being measured.

In planning and conducting the test, care should be exercised so that unrealistic internal gradients are not generated which could jeopardize the integrity of the instrument.

2.5 Electromagnetic Compatibility

Electromagnetic compatibility testing for the Flight Models shall be performed only at those frequencies delineated in the GIIS as affecting the Search and Rescue System. A full test series shall be performed if a design change is made from that as tested on the Engineering and/or Protoflight model.

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